OPTICAL PICKUP DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to an optical pickup device.

There has been known an optical disc (two-layer disc) having two layers of information recording surfaces (recording layers), as a method, for example, to increase recording capacity by enhancing recording density of DVD (digital video disc).

The two-layer disc is of the structure wherein a transparent protective base board, a first information recording surface, an intermittent layer, a second information recording surface and a protective base board on the reverse side are superposed in this order from the light source in the direction of an optical axis.

In the two-layer disc, a distance (thickness) from the surface of the transparent protective base board to the second recording layer is thicker than that from the surface of the transparent protective base board to the first recording layer by an amount of the intermittent layer, owing to the aforementioned structure. Therefore, spherical aberration caused by this thickness difference arises on each information recording surface.

However, in the case of DVD wherein a numerical aperture of an objective lens closer to an image is as relatively small as 0.6, it is possible to conduct recording and reproducing of information without correcting spherical aberration, because the spherical aberration stated above is in a range where there are no difficulties in practical use.

In recent years, there have been advanced research and development of the so-called high density optical disc wherein recording density has been enhanced by employing a blue laser beam having a wavelength of about 400 nm, by making a numerical aperture (NA) of an objective lens closer to an image to be about 0.85 and by making a protective base board thickness of an optical disc to be 0.1 mm, and further, there has been advanced development of a technology to make

such high density optical disc to be of the two-layer structure (for example, Patent Document 1).

The optical disc in the Patent Document 1 is one to use a high density optical disc of a two-layer type wherein NA is 0.8 or more, a distance from the surface of a transparent protective base board to the first information recording surface is 0.09 mm and a distance from the surface of a transparent protective base board to the second information recording surface is 0.11 mm, and to conduct appropriate spherical aberration correction for each information recording surface by obtaining an amount of correction for spherical aberration for each information recording surface.

(Patent Document 1)

TOKKAI No. 2002-373441

Incidentally, the technology in the aforementioned Patent Document 1 is one to be used for those wherein a blue laser beam having a wavelength of about 400 nm is used, NA is 0.85 or more, and a high density optical disc having a protective base board thickness of about 0.1 mm is made to be of a two-layer type.

Therefore, there is a problem that it is not easy to apply the technology in Patent Document 1 as it is for those, for example, wherein a high density optical disc (hereinafter

referred to as AOD (Advanced Optical Disc)) in which NA is controlled to be about 0.65 and a protective base board thickness is made to be about 0.6 mm is made to be of a two-layer structure.

SUMMARY OF THE INVENTION

Taking the aforementioned problems into consideration, an object of the invention is to provide an optical pickup device that is used for conducting recording and/reproducing of information for a high density optical disc having two information recording surfaces wherein a numerical aperture of an objective lens closer to an image is about 0.65 and a protective base board thickness is about 0.6 mm.

For solving the aforementioned problems, the structure described in Item 1 is characterized in that the structure can be used for conducting recording and/or reproducing of information for the first optical information recording medium having at least t1 ($0.5\ mm \leq t1 \leq 0.7\ mm$)-thick transparent protective base board, a first information recording surface, an intermittent layer and a second information recording surface which are laminated in this order from the part of a light source in the direction of an optical axis, and is provided with a spherical aberration

correcting mechanism that corrects spherical aberration caused by a thickness of the intermittent layer on a light-converged spot on each information recording surface when a light flux having at least wavelength $\lambda 1$ ($380 \text{ nm} \le \lambda 1 \le 450 \text{ nm}$) is converged on the first information recording surface and the second information recording surface.

The structure described in Item 1 makes it possible to correct spherical aberration caused on a light-converged spot on each information recording surface by a thickness of the intermittent layer by using a light flux with wavelength $\lambda 1$ ($380 \text{ nm} \le \lambda 1 \le 450 \text{ nm}$), even for a first optical information recording medium (two-layer structured AOD) having at least t1 ($0.5 \text{ mm} \le t1 \le 0.7 \text{ mm}$)-thick transparent protective base board, a first information recording surface, an intermittent layer and a second information recording surface.

The structure described in Item 2 is the optical pickup device described in Item 1 wherein, when the light flux with wavelength $\lambda 1$ is converged on one of the first and second information recording surfaces after the light flux with wavelength $\lambda 1$ has been converged on the other of the first and second information recording surfaces, the spherical aberration correcting mechanism stated above changes an angle

of incidence of the light flux with wavelength $\lambda1$ on the objective lens.

In the structure described in Item 2, the same effects as those in Item 1 are obtained, and when the light flux with wavelength $\lambda1$ is converged on the first information recording surface without aberrations substantially, for example, spherical aberration resulting from a thickness of the intermittent layer interposing between the first information recording surface and the second information recording surface is caused on the second information recording surface. Under such condition, when the light flux with wavelength $\lambda1$ is converged on the second information recording surface without aberrations substantially, it is possible to correct the spherical aberration on the second information recording surface to the level where there are no difficulties in practical use, by changing an angle of incidence of the light flux with wavelength $\lambda1$ on the objective lens.

Since these changes of an angle of incidence of the light flux with wavelength $\lambda1$ on the objective lens can be realized by moving optical elements such as a light source and a coupling lens, for example, constituting the optical

pickup device, in the direction of the optical axis, a mechanism for moving these light source and the optical element has only to be added newly to the structure of the conventional optical pickup device, which can control manufacturing cost of optical pickup devices.

The structure described in Item 3 is the optical pickup device described in Item 1 wherein, the spherical aberration correcting mechanism stated above moves an optical element arranged in an optical path of the light flux with wavelength $\lambda 1$, the aforementioned light source or that optical element and the light source, in the direction of the optical axis.

In the structure described in Item 3, the same effects as those in Item 1 are obtained, and the spherical aberration correcting mechanism stated above moves an optical element arranged in an optical path of the light flux with wavelength $\lambda 1$, the aforementioned light source or that optical element and the light source, in the direction of the optical axis. The optical element arranged in the optical path of the light flux with wavelength $\lambda 1$ means an optical element having a function to make an incident light flux to emerge after changing its angle of emergence, such as a collimator lens, a coupling lens and a beam expander into which a divergent

light flux enters respectively. Therefore, it is possible to correct spherical aberration caused by a thickness of the intermittent layer on a light-converged spot on each information recording surface, by moving these optical elements and light source in the direction of the optical axis, and thereby, by changing an angle of incidence of the light flux with wavelength λ1 on the objective lens.

The structure described in Item 4 is the optical pickup device described in Item 1 wherein, the wave-front aberration correcting mechanism stated above is provided with li crystal elements arranged in an optical path of the light quid flux with wavelength λ1 and controls refractive index distribution of the liquid crystal elements.

In the structure described in Item 4, the same effects as those in Item 1 are obtained, and an area of liquid crystal elements through which light fluxes with wavelength λ1 pass is divided into plural ring-shaped zonal areas whose centers are on the optical axis, and refractive index of each area is changed, thereby, the refractive index distribution in the area can be changed on a multi-step basis, and accuracy for correction of spherical aberration can be improved. Incidentally, it may be preferable that the liquid

crystal element is divided into a plurality of areas depending on phase difference and the number of areas is from 3 to 6, and that a phase difference Φ between neighboring areas among the plurality of areas satisfies the following formula:

$$2\pi \times 0.04 \leq |\Phi| \leq 2\pi \times 0.12.$$

The structure described in Item 5 is the optical pickup device described in Item 1 wherein there is provided an optical element made of plastic that is arranged in an optical path for the light flux with wavelength $\lambda1$, and the wave-front aberration correcting mechanism stated above changes characteristics of the optical element by giving temperature changes to the optical element.

In the structure described in Item 5, the same effects as those in Item 1 are obtained, and changes in forms have a great influence on changes of refractive indexes, because changes of refractive indexes caused by temperature changes of plastic are great. Therefore, the direction of the light flux with wavelength $\lambda1$ entering the optical element is changed, and as a result, an angle of incidence of the light flux with wavelength $\lambda1$ entering the objective lens is changed, and thus, spherical aberration can be corrected.

The structure described in Item 6 is the optical pickup device described in Item 1 or Item 3 wherein, the wave-front aberration correcting mechanism stated above corrects the spherical aberration mentioned above caused by individual differences of the light source.

In the structure described in Item 6, the same effects as those in Item 1 or Item 3 are obtained, and the spherical aberration mentioned above caused by individual differences of the light source can be corrected. As a correcting method, there is given a method wherein optical elements and a light source arranged in an optical path for the light flux with wavelength $\lambda 1$ are moved by the spherical aberration correcting mechanism in the direction of the optical axis. In particular, in the case of high density optical disc such as AOD, an influence by deviation of an oscillation wavelength caused by individual differences of the light source is great because a wavelength of a light flux is shorter than that for DVD or CD, therefore, it is important that the optical pickup device has a function to correct spherical aberration resulting from individual differences of the light source.

The structure described in Item 7 is the optical pickup device described in Item 1 wherein, an optical element which

does not operate during operation of the optical pickup device among optical elements arranged in the optical path for the light flux with wavelength $\lambda 1$, the aforementioned light source or that optical element and the light source are moved in the direction of the optical axis in the course of manufacturing optical pickup devices, for correcting spherical aberration caused on a light-converged spot on each information recording surface by deviation of an oscillation wavelength from the design wavelength resulting from individual differences of the light source.

In the structure described in Item 7, the same effects as those in Item 1 are obtained, and an optical element which does not operate during operation of the optical pickup device among optical elements arranged in the optical path for the light flux with wavelength $\lambda 1$, the light source or that optical element and the light source are moved by a worker in the direction of the optical axis in the course of manufacturing optical pickup devices, to correct the spherical aberration.

In this case, the optical element arranged in the optical path of the light flux with wavelength $\lambda 1$ means an optical element having a function to make an incident light

flux to emerge after changing its angle of emergence, such as a collimator lens, a coupling lens and a beam expander. Therefore, it is possible to correct spherical aberration by moving these optical elements and light source in the direction of the optical axis, and thereby, by changing an angle of incidence of the light flux with wavelength $\lambda 1$ on the objective lens.

When using a high density optical disc such as AOD, it is especially important that the optical pickup device has a function to correct spherical aberration resulting from individual differences of the light source.

The structure described in Item 8 is the optical pickup device described in either one of Items 1 - 7 wherein, a light flux with wavelength $\lambda 2$ ($650\ nm \le \lambda 2 \le 700\ nm$) is used to conduct recording and/or reproducing of information for the second optical information recording medium having a t2 ($0.5\ mm \le t2 \le 0.7\ mm$)-thick transparent protective base board.

In the structure described in Item 8, the same effects as those in either one of Items 1 - 7 are obtained, and it is possible to obtain an optical pickup device which can conduct recording and/or reproducing of information for DVD, for

example, as the second optical information recording medium and has compatibility.

The structure described in Item 9 is the optical pickup device described in either one of Items 1 - 8 wherein, a light flux with wavelength $\lambda 3$ (750 nm $\le \lambda 3 \le$ 850 nm) is used to conduct recording and/or reproducing of information for the third optical information recording medium having a t3 (1.1 mm $\le$ t3 $\le$ 1.3 mm)-thick transparent protective base board.

In the structure described in Item 9, the same effects as those in either one of Items 1 - 8 are obtained, and it is possible to obtain an optical pickup device which can conduct recording and/or reproducing of information for CD, for example, as the third optical information recording medium and has compatibility.

The structure described in Item 10 is the optical pickup device described in either one of Items 1 - 10 wherein, focal length f of the objective lens for the light flux having wavelength $\lambda 1$ satisfies 2.0 mm $\le$ f $\le$ 4.0 mm.

In the structure described in Item 10, the same effects as those in either one of Items 1 - 10 are obtained, and it

is possible to secure a sufficient working distance and to miniaturize an optical pickup device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing the structure of AOD.

Fig. 2 is a top view showing the structure of an optical pickup device.

Fig. 3 is a top view showing the structure of an optical pickup device.

Fig. 4 is a front view showing the structure of a liquid crystal element.

Fig. 5 is a top view showing the structure of an optical pickup device.

Fig. 6 is a front view showing a plastic lens and a heater.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

(First Embodiment)

The first embodiment of the optical pickup device of the invention will be explained as follows, referring to the drawings.

Fig. 1 is a sectional view of AOD representing first optical information recording medium 10.

The first optical information recording medium 10 is the so-called two-layer disc which is of the structure wherein transparent protective base board 11, first information recording surface 12, intermittent layer 13, second information recording surface 14 and protective base board 15 on the rear side are laminated in this order from the light source side in the optical axis direction (from the front to the rear).

Both of the transparent protective base board 11 and the intermittent layer 13 are made of transparent material through which a light flux can pass, and thickness t1 (distance in the optical axis direction) of the transparent protective base board 11 is about 0.6 mm, while, a thickness of the intermittent layer 13 is about 40 μm. Incidentally, the thickness t1 of the transparent protective base board 11 has only to be in a range of 0.5 mm - 0.7 mm, and the thickness of the intermittent layer 13 is not restricted in particular.

As shown in Fig. 2, optical pickup device 20 is composed schematically of a semiconductor laser representing light source 21, beam splitter 22 that transmits a light flux

with wavelength $\lambda 1$ ($350\ nm \leq \lambda \leq 450\ nm$) emitted from the semiconductor laser and branches the light flux reflected on the first optical information recording medium 10, objective lens 23 that forms a light-converged spot on each information recording surface by converging a light flux with wavelength $\lambda 1$ on each of the first information recording surface 12 and the second information recording surface 14, a two-dimensional actuator (not shown) that moves the objective lens in the prescribed direction, concave lens 24, photodetector 25 that detects reflected light coming from an optical information recording medium and spherical aberration correcting mechanism 30 that corrects spherical aberration caused on the light-converged spot by a thickness of the intermittent layer 13 of the first optical information recording medium 10.

Incidentally, the spherical aberration correcting mechanism 30 in Fig. 2 is shown only conceptually, and it does not limit the position of the optical pickup device 20 in the structure. Further, Fig. 2 shows only an ordinary structure of the optical pickup device 20, and an optical element having a function to change an angle of divergence of an incident light flux for emission such as, for example, a

collimator lens, a coupling lens and a beam expander, may also be arranged, in case of need.

Further, image-side numerical aperture (NA) of the objective lens 23 is 0.65.

Though the present embodiment has the structure of the so-called finite system wherein a light flux emitted from light source 21 enters the objective lens 23 as a divergent light, it is also possible to employ the structure of the infinite system wherein a collimator lens is arranged so that parallel light may enter the objective lens 23.

With regard to operations of the optical pickup device 20, a light flux with wavelength λ1 emitted from the light source 21 passes through beam splitter 22 and arrives at a plane of incidence of the objective lens 23 where the light flux is subjected to refraction actions and to diffraction actions, in case of need, to emerge from the objective lens 23, and is converged on the first information recording surface 12 or the second information recording surface 14 of the first optical information recording medium 10, thus, light-converged spot P is formed on optical axis L.

The light flux with wavelength λ1 is subjected to actions for modulating its wave front by spherical aberration

correcting mechanism 30 in an optical path covering from the light source 21 to each information recording surface, though detailed explanation will be given later. Owing to this, the light flux with wavelength $\lambda 1$ forms a light-converged spot under the condition that aberrations are substantially zero on each information recording surface, namely that spherical aberration is corrected to the level where there are no difficulties in practical use.

Next, the light flux with wavelength $\lambda 1$ is reflected on each information recording surface, then, passes through the objective lens 23 again and is reflected on the beam splitter 22 to be branched.

Then, the branched light flux enters photodetector 25 through concave lens 24, then, the photodetector 25 detects a spot of the incident light and outputs signals which are used to obtain signals for reading information recorded on an optical information recording medium.

Further, changes in an amount of light caused by changes in a form and position of the light-converged spot on the photodetector 25 are detected to conduct detection of focusing and tracking. Based on the results of the detection, the objective lens 23 is moved by the two-

dimensional actuator in the focusing direction and the tracking direction.

The spherical aberration correcting mechanism 30 will be explained next.

In the present embodiment, the spherical aberration correcting mechanism 30 has therein a driving apparatus (not shown) that moves light source 21 in the direction of optical axis L.

The structure of the driving apparatus is not restricted in particular, and a well-known actuator capable of moving the light source 21 straight such as, for example, a linear motor or a rotary motor is used.

For example, under the condition that the light flux with wavelength $\lambda 1$ is converged on the first information recording surface 12 without having no aberration substantially, spherical aberration resulting from a thickness of the intermittent layer 13 interposing between the first information recording surface 12 and the second information recording surface 14 is caused on the second information recording surface 14.

When converging the light flux with wavelength $\lambda 1$ on the second information recording surface 14, the spherical

aberration correcting mechanism 30 controls driving of the driving apparatus to move light source 21 toward the front (the direction to become more distant from the first optical information recording medium 10) by a prescribed amount. By moving the light source 21 forward by a prescribed amount as mentioned above, an angle of incidence of the light flux with wavelength $\lambda1$ on the objective lens 23 is changed, and the light flux with wavelength $\lambda1$ can be converged on the second information recording surface 14.

When the light source 21 is moved backward and forward by the spherical aberration correcting mechanism 30 as mentioned above, spherical aberration of the light-converged spot on the image recording surface on the side where reproducing and/or recording of information is conducted can be corrected to the level where there are no difficulties in practical use.

Incidentally, in the present embodiment, an angle of incidence of the light flux with wavelength $\lambda1$ on the objective lens 23 is changed when the light source 21 is moved backward and forward by the spherical aberration correcting mechanism 30. However, without being limited to the foregoing, it is also possible to change an angle of

incidence of the light flux with wavelength λ1 on the objective lens 23 by arranging an optical element (collimator or coupling lens) that changes an angle of divergence of an incident light flux and makes it to emerge in the optical path of the light flux with wavelength λ1, and thereby by moving the optical element backward and forward.

Further, in the present embodiment, recording and/or reproducing of information is conducted for a two-layered high density disc having transparent protective base board 11 with thickness t1 of 0.6 mm by using a light flux with wavelength λ1. In addition to this, it is also possible to arrange, by adding a structure to the foregoing, so that recording and/or reproducing of information can also be conducted for the second optical information recording medium (for example, DVD) having a transparent protective base board with thickness t2 ($0.5\ mm \leq t2 \leq 0.7\ mm$) by using a light flux with wavelength λ2 ($650\ nm \leq \lambda 2 \leq 700\ nm$), or it is also possible to arrange, by adding a structure to the foregoing, so that recording and/or reproducing of information can further be conducted for the third optical information recording medium (for example, CD) having a transparent protective base board with thickness t3 ($1.1\ mm \leq t3 \leq 1.3$

mm) by using a light flux with wavelength $\lambda 3$ (750 nm $\leq \lambda 3 \leq$ 850 nm). In this case, either one of the second optical information recording medium and the third optical information recording medium, or both of them may be made to be of a two-layer structure.

As the second optical information recording medium, an optical disc such as, for example, MD (mini-disc) or MO (magneto-optic disc) can be used in addition to DVD, and as the third optical information recording medium, an optical disc such as, for example, CD-R or RW (write-once compact disc) can be used in addition to CD.

It is further preferable that focal length f of objective lens 23 for the light flux with wavelength $\lambda 1$ is made to be in a range of 2.0 mm - 4.0 mm. If the focal length f is greater than 4.0 mm, optical pickup device 20 is enlarged in terms of size in the direction of an optical axis, and if the focal length f is smaller than 2.0 mm, on the other hand, a working distance of the optical pickup device 20 becomes too short, resulting in a fear that the first optical information recording medium 10 in operation interferes with the objective lens 23.

It is further possible to arrange so that the spherical aberration correcting mechanism 30 corrects spherical aberration caused on light-converged spot P on each information recording surface by deviation of an oscillation wavelength from the design wavelength resulting from individual differences of light source 21, or to arrange so that the spherical aberration is corrected when an optical element which does not operate in the course of operation of the optical pickup device 20 among optical elements arranged in an optical path for a light flux with wavelength $\lambda 1$, or light source 21 or both the optical element and the light source 21 are moved in the optical axis direction by a worker in the course of manufacturing the optical pickup device 20.

(Second Embodiment)

Next, the second embodiment of the invention will be explained as follows, referring to the drawings.

In the present embodiment, a main difference from the first embodiment mentioned above is that the spherical aberration correcting mechanism 30 is provided with liquid crystal element 31 and liquid crystal element drive circuit 32 which are arranged in the optical path for the light flux

with wavelength $\lambda 1$, and this difference will be explained mainly as follows.

As shown in Fig. 3 and Fig. 4, the liquid crystal element 31 is arranged in front of the objective lens 23, and is divided into plural (three in the present embodiment) areas 31a - 31c which are in a form of concentric circles each having its center on the optical axis.

On each of the areas 31a - 31c, there is formed a pattern of a transparent electrode that is made, for example, of indium-tin-oxide alloy. The liquid crystal element is in the structure wherein the refractive index of each of the areas 31a - 31c is constant before voltage is impressed on the liquid crystal 31, and then, the refractive index of each of the areas 31a - 31c can be changed by controlling an amount of voltage to be impressed on each of the areas 31a - 31c with liquid crystal element drive circuit 32.

For example, when the light flux with wavelength $\lambda 1$ is converged on the second information recording surface 14 under the condition that the light flux with wavelength $\lambda 1$ is converged on the first information recording surface 12 without having no aberrations substantially and spherical

aberration resulting from a thickness of intermittent layer 13 is caused on the second information recording surface 14, an unillustrated control section controls an amount of voltage to be impressed, by liquid crystal element drive circuit 32, on each of the areas 31a - 31c of the liquid crystal element 31 based on output signals coming from photodetector 25, and changes the refractive index of each of the areas 31a - 31c.

Due to this, an angle of incidence of the light flux with wavelength λ1 on the objective lens 23 is changed, and thereby, it is possible to modulate a wave front of the light flux with wavelength λ1 properly in each area, and to converge the light flux with wavelength λ1 on the second information recording surface 14 without having no aberrations substantially.

By adjusting voltage to be impressed on liquid crystal element 31 as stated above, it is possible to change distribution of refractive index of the liquid crystal element 31 and thereby to correct spherical aberration of the light-converged spot on the information recording surface on the side to conduct reproducing and/or recording of

information to the level where there are no difficulties in practical use.

(Third Embodiment)

Next, the third embodiment of the invention will be explained as follows, referring to the drawings.

As shown in Fig. 5 and Fig. 6, in the present embodiment, optical element 26 made of plastic (hereinafter referred to as "plastic lens") is arranged in the optical path for the light flux with wavelength $\lambda 1$, and a main difference from the first embodiment mentioned above is that the spherical aberration correcting mechanism 30 is provided with heater 33 that changes temperature of the optical element and with heater drive circuit 34, and this difference will be explained mainly as follows.

As plastic lens 26, a plastic lens used generally as a lens constituting a light converging optical system of optical pickup device 20 such as, for example, a collimator lens, a coupling lens and objective lens 23 may be employed, or plastic lens 26 may be incorporated separately in a light converging optical system.

As shown in Fig. 6, a circumference of the plastic lens 26 is covered by dielectric coil 33a representing heater 33. In the structure, an unillustrated control section controls

an amount of high-frequency voltage to be impressed on dielectric coil 33a by heater drive circuit 34 based on output signals coming from photodetector 25, and thereby, temperature of plastic lens 26 itself generated by heating of dielectric coil 33a can be adjusted, and changes of a form and refractive index of the plastic lens 26 caused by temperature changes can be adjusted.

For example, under the condition that a light flux with wavelength λ1 is converged on the first information recording surface 12 without having no aberration substantially, spherical aberration resulting from a thickness of intermittent layer 13 is caused on the second information recording surface 14 as stated above.

Then, when the heater drive circuit 34 controls an amount of voltage to be impressed on dielectric coil 33a in the case where the light flux with wavelength λ1 is made to be converged on the second information recording surface 14 without having aberrations substantially, temperature of the plastic lens 26 is changed and a form and refractive index of the plastic lens 26 are changed by its expansion. Therefore, a direction of advancement of the light flux with wavelength

$\lambda 1$ that has entered the plastic lens 26 is changed, and an angle of incidence on the objective lens 23 is also changed.

By adjusting a form of the plastic lens 26 as stated above, an angle of incidence of the light flux with wavelength $\lambda 1$ on objective lens 23 can be changed as explained in the first embodiment.

Further, by adjusting refractive index of the plastic lens 26, a wave front of the light flux with wavelength $\lambda 1$ passing through the plastic lens 26 can be modulated as explained in the second embodiment.

By adjusting an amount of voltage to be impressed on dielectric coil 33a as stated above, it is possible to change a form and refractive index of the plastic lens 26, and to correct spherical aberration of a light-converged spot on an information recording surface on the side for conducting reproducing and/or recording of information to the level where there are no difficulties in practical use.

Incidentally, though dielectric coil 33a is used as heater 33 in the present embodiment, it is also possible to use a well-known heater such as, for example, a heating wire, without being limited to the foregoing.

(Effect of the invention)

The invention makes it possible to obtain an optical pickup device wherein NA is about 0.65, a thickness of a protective base board is about 0.6 mm and spherical aberration caused on a light-converged spot on each information recording surface by a thickness of an intermittent layer can be corrected even for high density optical disc having two information recording surfaces.